

BOTANICAL GAZETTE

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Evolution and classification.¹

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As we have gathered up the scattered masses of botanical knowledge, laboriously wrought out by many isolated workers, and attempted to fit them together into a consistent whole, which should outline the structure of the temple of botany, we have found that the workmen have not always followed the same architectural plan, and have often used different units of measurement. With the increasing specialization so noticeable year by year there is a corresponding lack of coordination of work. To this lack of coordination, this want of unity of measurement, this misunderstanding of plan, we can no longer close our eyes, and I therefore feel free to invite your attention to the following somewhat summary discussion of the causes of the present unsatisfactory condition, in the hope that we may thereby be enabled to see how we may make some improvement.

All botanical knowledge finally culminates in some kind of classification. The facts of histology, morphology and physiology are of great biological importance, but the greatest of all biological facts is that the world is peopled with living things. We may group and arrange in orderly sequence the histological facts of the science; we may do likewise with the facts which the morphologist has discovered; we may make a classification of all the known physiological facts; but beyond and above these lies the greatest grouping of all, the grouping in orderly sequence of the organisms themselves, whose histology, morphology and physiology we have studied.

It is now a full third of a century since a great light was first turned upon all biological problems by the formulation of the doctrine of evolution by the master mind of Darwin. In

¹ Abstract of Vice-presidential address before Section G of the American Association for the Advancement of Science, Madison meeting, August, 1893.

its light many puzzles have been solved, and many facts hitherto inexplicable have been made plain. We now know what relationship means, and we have given a fuller meaning to the natural system of classification. From the new point of view a natural classification is not merely an orderly arrangement of similar organisms. It is an expression of genetic relationship. Furthermore in the light of evolution we now see the meaning of many reduced structures whose significance was not at all or but vaguely understood. We have become familiar with the fact that degradation is a prominent factor in the vegetable kingdom. Evolution has by no means always involved an advance in structural complexity. Often this catagenesis is a result of parasitism or saprophytism, as is so well illustrated in the fungi, where the degradation has gone so far that their relationship has to a great degree been obscured.

But there are many cases of a catagenesis not due to a dependent habit, in which we have evidence of a simplification from a more complex structure. Thus in the willows and poplars, where we have a raceme of very simple flowers, each consisting of a single ovary, or one to many stamens, it is readily seen that this simplicity is not primitive. The ovaries are not single carpels, but are composed of two or three united. The flower of a willow is simple by a degeneration from a higher type, probably a tricarpellary or pentacarpellary type, by the loss of its floral envelopes and stamens and pistils.

Every naturalist should be as familiar with these illustrations of evolution by simplification as he is with those of evolution by complication. In the growth of the great tree of life, while the development has been most largely in an upward direction so that the great body of the tree has risen far above its point of beginning, there are yet multitudes of twigs and branchlets which droop downward.

I need not now, before a body of scientific men, speak of evolution as an hypothesis, for we know it as a great biological fact, about whose existence there is no shadow of doubt. A natural classification will conform strictly to the lines of evolution, it will be in fact a clear exposition of the successive steps in its progress. In such a classification the primitive forms will precede the derived ones, and the relation of the latter will be positively indicated. Moreover, in such a sys-

tem there will be no confusion between the primitively simple forms and those which are so by derivation.

An examination of our common systems shows them sadly deficient in the essentials of a scientific classification. This is particularly true of the treatment of the flowering plants, at the hands of English and American botanists. Nothing could show better the conservatism of botanists than the fact that for a third of a century after the general acceptance of the doctrine of evolution, they are still using so crude an arrangement of the group of plants with which they are most familiar.

I may assume that it is well known to nearly all of us that the prevailing arrangement of the dicotyledons does not represent the later views of any of the systematists. The fact is that the systematic disposition of the higher plants is at present a make-shift, maintained by conservatism, and a reverence for the time-honored work of the fathers. It is unscientific to let our practice drag behind the present state of our knowledge: it is far more so for us to cling to the opinions of our fathers, through mere reverence, long after we know them to be untenable. It is not to the credit of our science that for a second time she has persistently held to a system through such considerations. For thirty or forty years after a natural system had been constructed by Jussieu, botanists as a body still adhered to the artificial system of Linné. Now sixty years later we find ourselves faced with a problem similar to that which Lindley, Torrey, Beck, and Gray met. History repeats itself with such exactness that with the change of a word here and there the arguments *pro* and *con* then used may be used to-day. The system of Jussieu and DeCandolle is now as much a clog and a hindrance to the systematic botany of the higher plants, as was that of Linné sixty years ago, and now, as then, it is the spirit of conservatism and of veneration for time honored usage which maintains the incubus.

Manifestly a system of classification which conforms to and is based upon the doctrine of evolution must begin with those forms which are primitive, or which, as nearly as may be, represent primitive forms. Since the flower is a shoot in which the phyllomes are modified for reproductive purposes, that flower in which the phyllomes are least modified must be regarded as primitive, while that in which there is most modification

must be regarded as departing most widely from the primitive type. The simple pistil, developed from a single phyllome is primitive and lower, the compound pistil is derived and higher. The several-seeded, compound ovary must be lower, and the compound ovary with but one seed must be higher. Separate stamens are primitive; united stamens, whether the union be with one another or with other structures, must be derived and consequently higher. So too when all parts of the flower are separate it is a primitive condition, and when they are united it is a derived structure.

Applying these principles to the flowering plants it becomes evident that in the dicotyledons either the Apetalæ or the Polypetalæ must furnish our starting point. The Gamopetalæ are universally admitted to be higher than the groups just mentioned, and certainly do not contain the sought for primitive types. Even a hasty examination of the thirty-six apetalous families shows that they are, at least to a very large extent, derived from the Polypetalæ by the abortion of some parts, and the entire omission of others. It will not be difficult to determine that the Ranales must take rank below all other Polypetalæ, in the sense of representing more nearly than any other group the primitive dicotyledons.

The attempt to make a natural system by linking family to family in a long undulating chain, by concatenation, is unscientific because it absolutely fails to conform to the laws of evolution. We must abandon the old classification and attempt one which in the light of evolution is rational. Let us not cling to the old because it is inconvenient to change, let us not cling to it through a mistaken reverence for the practice of the fathers, let us not cling to it as long as a flaw may be found in a new system. Science is ever abandoning the old, when the old is no longer the true; it tears down the work of years, when that work no longer represents the truth, and it dares to reach out and frame a rational system even though some parts of it for a time rest upon hypothetical grounds.

A revised arrangement of the Benthamian "series" of flowering plants.

Monocotyledons.

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| 1. Apocarpæ. | 5. Glumaceæ. |
| 2. Coronariææ. | 6. Hydrales. (Hydrocharideæ.) |
| 3. Nudifloræ. | 7. Epigynæ. |
| 4. Calycinæ. | 8. Microspermæ. |

Dicotyledons.

"POLYPETALÆ."

1. Thalamifloræ. (Including the apetalous Curvembryeæ, Micrembryeæ, and "Ordines anomali" and the Euphorbiaceæ and Urticaceæ, etc., of the Unisexuales.)
2. Discifloræ. (Including the apetalous Daphnales and the Juglandaceæ and Cupuliferæ, etc., of the Unisexuales.)
3. Calycifloræ. (Including the apetalous Aristolochiaceæ and Cytinaceæ).

GAMOPETALÆ.

1. Heteromeræ.
2. Bicarpellatæ.
3. Inferæ.

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Proceedings of Section G, A. A. A. S., Madison meeting.

The American Association for the Advancement of Science convened in Madison, Wis., Thursday, August 17, 1893, and continued in session until the succeeding Tuesday. The following account is an outline of the addresses, papers and discussions before the section of botany, in the order in which they were presented.

THURSDAY AFTERNOON, AUGUST 17.

The address of Vice-President C. E. Bessey upon *Evolution and Classification* was given before the Section of Botany at half-past four o'clock, occupying one hour. An abstract of the address is printed in the preceding pages of this number.

FRIDAY MORNING, AUGUST 18.

The Section was called to order at 10:30 o'clock, Vice-President Bessey in the chair, and B. T. Galloway as secretary pro tem., with about forty persons present. The reading of papers began at once.

1. GEO. F. ATKINSON: *Photography as an instrument for recording the microscopic characters of micro-organisms in artificial cultures.*—In the usual method of lighting for photographing plate cultures, the finer characteristics are usually lost, and in case of very transparent colorless organisms the image is throughout very dim. By covering the bottom and